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Abstract

Operation and Experimental Utilization of the High-Flux Research Reactor DR 3

by

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The reactor DR 3, belonging to the Danish Atomic Energy Commission, is a replica of the English Pluto reactor: 10 MW thermal power, D_2O moderated and cooled, with 26 fuel elements of the MTR type and a maximum thermal flux in the middle of the core of approx. 1.6×10^{14} n/cm^2 sec. It was built by the English company Head Wrightson Processes, Ltd., in 1957-59.

Criticality was reached in January 1960 and full power in October. Since April 1961 the reactor has been operated at full power in periods of 4 weeks with an overall on-power time of approx. 75%.

Reactor operation and experiments have not been attended with any serious trouble. 230 fuel elements have all worked excellently. 6 containers with spent fuel (150 elements) have successfully been sent to Dounreay in Scotland for reprocessing. The D_2O concentration, originally 99.79% by weight, has dropped at a rate of 0.002%/month to 99.70%. The pD has been lowered from 6.2 to 5.6 to diminish the rate of corrosion. The water is still clear without any visible sign of Al-hydroxide. The control system has worked satisfactorily. Leakage problems in the fine-control rod will be finally solved by substituting a D_2O-cooled rod. The safety rods will be replaced by more effective ones.

During full power operation 92 unwanted shut-downs have occurred, 52% of which were caused by failure of the mains. No radiation damage to persons has occurred, and evacuation of staff from the reactor building has never been necessary.

Kinetic experiments have been made to elucidate some of the problems of failure of primary cooling and to provide a basis for a reactor model. This

model is not yet capable of handling powers above approx. 20 MW, but will be modified in the near future to cover higher power ranges.

Occasionally, many power dips of 200-2000 kW, lasting for approx. 10-15 sec, have been observed. Rise of power has occurred very few times. Investigations have been concentrated on the possibility of mechanical vibrations of components in the core causing this trouble. Measurements have shown that the noise spectrum varies appreciably, sometimes containing heavy components of frequencies around 1 Hz. Extensive measurements have been planned for the spring of 1964.

The experiments may be divided into two categories, beam experiments with high-quality neutron beams and materials testing experiments, some of which have been carried out for or in co-operation with foreign countries and for the Dragon project. Graphite, uranium, steel, and zircalloy have been irradiated.

Among planned experiments may be mentioned an organic-loop irradiation, for the reactor study project DOR, of a fuel rod consisting of SAP and UO_2, with OM 2 as coolant. The working pressure will be 24 at and T_{out} 425° C for investigation of fouling, heat transmission and metallurgical problems.

Another experiment is being planned to elucidate the mechanical properties of SAP and UO_2 pellets and the interaction between these materials under in-pile conditions.